

AMENDMENTS TO THE CLAIMS

Claim 1 (Original) An image processing apparatus comprising:

a contrast improvement unit operable to perform a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;

an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image; and

an image output unit operable to output the image after combination.

Claim 2 (Original) The image processing apparatus of claim 1 wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount for a pixel in the input image; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of a corresponding pixel in the enhanced image according to the extracted range.

Claim 3 (Original) The image processing apparatus of claim 1 wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of a corresponding pixel in the enhanced image according to the extracted range.

Claim 4 (Currently Amended) The image processing apparatus of claim 2 or 3 wherein

the pixel value conversion unit comprises: an average brightness calculation unit operable to calculate an average brightness of pixels in the input image; a conversion method selection unit operable to select a method of converting a contrast improvement amount to a value of pixel in

the enhanced image based on the average brightness; and a pixel value estimation unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image according to the selected conversion method.

Claim 5 (Currently Amended) The image processing apparatus of claim 2 or 3 wherein
the pixel value conversion unit comprises: a standard intensity calculation unit operable to calculate a standard intensity value that indicates contrast intensity of the input image; a conversion curve estimation unit operable to estimate a conversion curve for converting the contrast improvement amount to a value in the enhanced image based on the standard intensity value; and a pixel value estimation unit operable to use the conversion curve to convert the contrast improvement amount to a value in the enhanced image.

Claim 6 (Original) The image processing apparatus of claim 5 wherein
the conversion curve estimation unit comprises: an initial candidate setting unit operable to set an initial population of search vectors that indicate conversion curves; a pixel value conversion candidate calculation unit operable to find a conversion value in a candidate for an enhanced image from the contrast improvement amount using a conversion curve candidate corresponding to each search vector; an evaluation value calculation unit operable to use the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a fitness calculation unit operable to calculate fitness of a candidate of each conversion curve based on the evaluation value; a recombination operation unit operable to perform recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve and generate a next generation population; and an estimation end judgment unit operable to determine whether or not estimation of the conversion curve ends at a current generation.

Claim 7 (Original) The image processing apparatus of claim 1 wherein

the contrast improvement unit comprises: a signal conversion unit operable to convert a value of pixel in the input image to a plurality of signals that include a signal that is an object of contrast improvement; an object correction data calculation unit operable to find a contrast improvement amount of the object pixel for an object signal obtained from the signal conversion unit; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount for the object signal; an object signal conversion unit operable to convert the contrast improvement amount for the object signal to a value of the object signal in the enhanced image; and a signal inverse conversion unit operable to find a value of pixel in the enhanced image based on the object signal of the enhanced image and signals other than the object signal obtained by the signal conversion unit.

Claim 8 (Original) The image processing apparatus of claim 1 wherein

the contrast improvement unit comprises: a signal conversion unit operable to convert a value of pixel in the input image to a signal that is an object of contrast improvement; an object correction data calculation unit operable to find a contrast improvement amount by comparing the object signal of the object pixel with the object signals of pixels that belong to each of surrounding areas with different sizes; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount for the object signal; an object signal conversion unit operable to convert a contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the extracted range; and a signal inverse conversion unit operable to find a value of pixel in the enhanced image based on the object signal of the enhanced image and signals other than the object signal obtained by the signal conversion unit.

Claim 9 (Currently Amended) The image processing apparatus of claim 7 or ~~claim 8~~
wherein

the object signal conversion unit comprises: an average object signal calculation unit operable to calculate an average value of the object signal in the input image; a conversion

method selection unit operable to select a conversion method for converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the average value; and an object signal estimation unit operable to convert the contrast improvement amount for the object signal to the value of the object signal in the enhanced image according to the selected conversion method.

Claim 10 (Original) The image processing apparatus of claim 7 or 8 wherein

the object signal conversion unit comprises: a standard intensity calculation unit operable to calculate a standard intensity value that indicates contrast intensity of the input image for the object signal obtained by the signal conversion unit; an object signal conversion curve estimation unit operable to estimate a conversion curve for converting the contrast improvement amount for the object signal to the value in the enhanced image based on the standard intensity value; and an object signal estimation unit operable to use the estimated conversion curve to convert the contrast improvement amount for the object signal to the value in the enhanced image.

Claim 11 (Original) The image processing apparatus of claim 10 wherein

the object signal conversion curve estimation unit comprises: an initial candidate setting unit operable to set an initial population of search vectors that indicate conversion curves; an object signal conversion candidate calculation unit operable to find a conversion value for the object signal in a candidate for an enhanced image from the contrast improvement amount for the object signal using a conversion curve candidate corresponding to each search vector; an evaluation value calculation unit operable to use the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a fitness calculation unit operable to calculate fitness of a candidate of each conversion curve based on the evaluation value; a recombination operation unit operable to perform recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve and generate a next generation population; and an estimation end judgment unit operable to determine whether or not estimation of the conversion curve ends at current generation.

Claim 12 (Original) The image processing apparatus of claim 1 wherein
the image combination unit comprises: a selection standard judgment unit operable to determine whether the input image or enhanced image has priority; a combination coefficient calculation unit operable to set combination coefficients for the input image and enhanced image based on the judgment of the selection standard judgment unit; and a weighted average combination unit operable to use the combination coefficients set for each image to generate a weighted average image of the input image and enhanced image.

Claim 13 (Original) An image processing apparatus comprising:
a contrast improvement unit operable to perform a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;
an edge data detection unit operable to detect edge data of the input image;
an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit with the input image based on the edge data obtained by the edge data detection unit; and
an image output unit operable to output an image after combination.

Claim 14 (Original) The image processing apparatus of claim 13 wherein
the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount for a pixel in the input image; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 15 (Original) The image processing apparatus of claim 13 wherein
the contrast improvement unit comprises: a correction data calculation unit operable to find the contrast improvement amount by comparing the object pixel with pixels that belong to

each of surrounding areas with different sizes; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert a contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 16 (Original) The image processing apparatus of claim 13 wherein
the image combination unit comprises: a combination coefficient calculation unit operable to calculate combination coefficients for the input image and enhanced image based on the edge data obtained from the input image; and a weighted average combination unit operable to generate a weighted average image for the input image and enhanced image based on the combination coefficients calculated for each image.

Claim 17 (Original) An image processing apparatus comprising:
a contrast improvement unit operable to perform a contrast improvement process on an input image by comparing an object pixel in the input image with pixels that belong to surrounding areas of the object pixel;
a density correction unit operable to correct density distribution of an enhanced image obtained by the contrast improvement unit according to density distribution of the input image;
an image combination unit operable to combine a corrected image obtained by the density correction unit and the input image; and
an image output unit operable to output an image after combination.

Claim 18 (Original) The image process apparatus of claim 17 wherein
the image combination unit comprises: a weighted average combination unit operable to generate a weighted average image for the input image and enhanced image; and an output value setting unit operable to set a value of pixel in an output image based on the image obtained by the weighted average combination unit and the input image.

Claim 19 (Original) An image processing apparatus comprising:

an edge data detection unit operable to detect edge data of an input image;

a contrast improvement unit operable to perform a contrast improvement process on the input image by determining an area where an object pixel belongs based on the edge data of the object pixel obtained by the edge data detection unit and brightness of the object pixel, and by comparing the object pixel with pixels that belong to surrounding areas of the object pixel;

an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image; and

an image output unit operable to output an image after combination.

Claim 20 (Original) The image processing apparatus of claim 19 wherein

the image combination unit comprises: a weighted average combination unit operable to generate a weighted average image for the input image and enhanced image; and an output value setting unit operable to set a value of pixel in the output image based on the image obtained by the weighted average combination unit and the input image.

Claim 21 (Original) An image processing apparatus comprising:

an edge data detection unit operable to extract edge data of an input image;

a contrast improvement unit operable to perform a contrast improvement process on the input image by determining an area where an object pixel belongs based on the edge data of the object pixel obtained by the edge data detection unit and brightness of the object pixel, and by comparing the object pixel with pixels that belong to surrounding areas of the object pixel;

an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image based on the edge data obtained by the edge detection unit; and

an image output unit operable to output an image after combination.

Claim 22 (Currently Amended) The image processing apparatus of claim 19 or claim 21
wherein

the contrast improvement unit comprises: an area judgment unit operable to determine an area where the object pixel belongs based on edge data; a comparison range setting unit operable to select a pixel comparison range based on the area obtained by the area judgment unit; a correction data calculation unit operable to find a contrast improvement amount for the object pixel based on the pixel comparison range selected by the comparison range setting unit; an adjustment coefficient calculation unit operable to calculate an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment unit; an adjustment unit operable to correct the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation unit; an extraction unit operable to extract an effective range from distribution of the corrected contrast improvement amount; and a pixel value conversion unit operable to convert the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 23 (Currently Amended) The image processing apparatus of claim 19 or claim 21
wherein

the contrast improvement unit comprises: an area judgment unit operable to determine an area where the object pixel belongs based on the edge data; a correction data calculation unit operable to find a contrast improvement amount by comparing the object pixel with a pixel that belongs to each of surrounding areas having different sizes; an adjustment coefficient calculation unit operable to calculate an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment unit; an adjustment unit operable to correct the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation unit; an extraction unit operable to extract an effective range from distribution of the corrected contrast improvement amount; and a pixel value conversion unit operable to convert the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 24 (Original) An image processing apparatus comprising:

a contrast improvement unit having a correction data calculation density binding unit operable to bind density of a pixel in an area surrounding an object pixel in an input image, wherein the contrast improvement unit performs a contrast improvement process on the input image in the bound state by comparing the object pixel of the input image with pixels of the surrounding area; and

an image output unit operable to output an enhanced image obtained by the contrast improvement unit.

Claim 25 (Original) An image processing apparatus comprising:

a contrast improvement unit having a correction data calculation density binding unit operable to bind density of a pixel in an area surrounding an object pixel in an input image, wherein the contrast improvement unit performs a contrast improvement process on the input image in the bound state by comparing the object pixel of the input image with pixels of the surrounding area;

an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image; and

an image output unit operable to output an image after combination.

Claim 26 (Currently Amended) The image processing apparatus of claim 24 or claim 25 wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount of the object pixel; an extraction unit operable to extract an effective range from distribution of contrast; and a pixel value conversion unit operable to convert the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

Claim 27 (Currently Amended) The image processing apparatus of claim 24 or ~~claim 25~~
wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable to convert the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

Claim 28 (Original) An image processing apparatus comprising:

a pre-processing unit operable to perform pre-processing on an input image;

a contrast improvement unit operable to perform a contrast improvement process on the pre-processed image by comparing an object pixel of the pre-processed image with pixels that belong to surrounding areas of the object pixel;

an image combination unit operable to combine an enhanced image obtained by the contrast improvement unit and the input image;

a post-processing unit operable to perform post-processing on an image after combination;
and

an image output unit operable to output the post-processed image.

Claim 29 (Original) The image processing apparatus of claim 28 wherein

the contrast improvement unit comprises: a comparison pixel setting unit operable to set comparison pixels from among pixels in the area surrounding the object pixel to be used in the comparison; a correction data calculation unit operable to find a contrast improvement amount of the object pixel; a conversion standard value calculation unit operable to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 30 (Original) The image processing apparatus of claim 29 wherein

the correction data calculation unit comprises: a surrounding average unit operable to find a weighted average for density of the comparison pixels; and an improvement amount calculation unit operable to find a contrast improvement amount from the average density obtained by the surrounding average unit and density of the object pixel.

Claim 31 (Original) The image processing apparatus of claim 29 wherein

the correction data calculation unit comprises: a surrounding average unit operable to find a weighted average for density of the comparison pixels; an edge data detection unit operable to detect edge data of the object pixel; a correction coefficient calculation unit operable to calculate a correction coefficient for the edge data based on the edge data obtained by the edge data detection unit; a comparison amount correction unit operable to correct the average density obtained by the surrounding average unit using the correction coefficient; and an improvement amount calculation unit operable to find a contrast improvement amount from the corrected average density and the density of the object pixel.

Claim 32 (Original) The image processing apparatus of claim 29 wherein

the correction data calculation unit comprises: a surrounding average unit operable to find a weighted average for density of the comparison pixels; an improvement amount calculation unit operable to find a contrast improvement amount from the average density obtained by the surrounding average unit and the density of the object pixel; an enhancement component calculation unit operable to calculate an enhancement component from difference in the density of the comparison pixel and the object pixel; and an improvement amount correction unit operable to add the enhancement component to the contrast improvement amount.

Claim 33 (Original) The image processing apparatus of claim 28 wherein

the contrast improvement unit comprises: a comparison pixel setting unit operable to set positions in a vertical direction of pixels to be used in the comparison from among pixels in the

area surrounding the object pixel; a vertical direction addition unit operable to add weighting in the vertical direction to the density of the comparison pixels obtained by the comparison pixel setting unit; a simple surrounding average unit operable to calculate comparison density for the object pixel from a value at each horizontal pixel position in the surrounding area obtained by the vertical direction addition unit; an improvement amount calculation unit operable to find a contrast improvement amount from the comparison density and density of the object pixel; a conversion standard value calculation unit operable to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 34 (Original) The image processing apparatus of claim 28 wherein

the contrast improvement unit comprises: a comparison pixel setting unit operable to set positions in a vertical direction and positions in a horizontal direction of pixels to be used in the comparison from among pixels in the area surrounding the object pixel ; a removal vertical direction addition unit operable to add weighting to the vertical direction of the density of the comparison pixels obtained by the comparison pixel setting unit; a simple surrounding average unit operable to calculate comparison density for the object pixel based on an addition value obtained by the removal vertical direction addition unit; an improvement amount calculation unit operable to find a contrast improvement amount from the comparison density and density of the object pixel; a conversion standard value calculation unit operable to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 35 (Original) The image processing apparatus of claim 28 wherein

the pre-processing unit performs inverse conversion of gamma conversion on the input image in advance.

Claim 36 (Original) The image processing apparatus of claim 35 wherein
the post-processing unit performs the gamma conversion.

Claim 37 (Original) The image processing apparatus of claim 28 wherein
the post-processing unit comprises: an input brightness/color calculation unit operable to calculate a brightness value and color difference components of the input image; a brightness adjustment unit operable to compare a brightness component of the input image obtained by the input brightness/color calculation unit with the brightness component of a combined image and adjust the brightness component of the combined image; a color component correction unit operable to correct the color difference components of the input image obtained by the input brightness/color calculation unit based on the brightness component of the combined image obtained by the brightness adjustment unit; an image regeneration unit operable to regenerate the combined image using the brightness component of the combined image obtained by the brightness adjustment unit and the corrected color difference components obtained by the color component correction unit; and a gamma conversion unit operable to perform gamma conversion on the combined image obtained by the image regeneration unit.

Claim 38 (Original) An image processing method comprising:
a contrast improvement step of performing a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;
an image combination step of combining an enhanced image obtained from the contrast improvement unit and the input image; and
a step of outputting an image after combination.

Claim 39 (Original) The image processing method of claim 38 wherein
the contrast improvement step comprises: a step of finding a contrast improvement amount for a pixel in the input image; a step of extracting an effective range from distribution of

the contrast improvement amount; and a pixel value conversion step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 40 (Original) The image processing method of claim 38 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; a step of extracting an effective range from distribution of the contrast improvement amount; and a pixel value conversion of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 41 (Currently Amended) The image processing method of claim 39 or 40 wherein the pixel value conversion step comprises: a step of calculating an average brightness of pixels in the input image; a step of selecting a method of converting the contrast improvement amount to a value of pixel in the enhanced image based on the average brightness; and a step of converting the contrast improvement amount to a value of pixel in the enhanced image according to the selected conversion method.

Claim 42 (Currently Amended) The image processing method of claim 39 or 40 wherein

the pixel value conversion step comprises: a step of calculating the standard intensity value that indicates contrast intensity of the input image; a conversion curve estimation step of estimating a conversion curve for converting the contrast improvement amount to a value in the enhanced image; and a step of using the conversion curve to convert the contrast improvement amount to a value in the enhanced image.

Claim 43 (Original) The image processing method of claim 42 wherein

the conversion curve estimation step comprises: a step of setting an initial population of search vectors that indicate conversion curves; a step of finding a conversion value in a candidate for an enhanced image from the contrast improvement amount using a conversion curve candidate corresponding to each search vector; a step of using the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a step of calculating fitness of a candidate of each conversion curve based on the evaluation value; a step of performing recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve and generating a next generation population; and a step of determining whether or not estimation of the conversion curve ends at current generation.

Claim 44 (Original) The image processing method of claim 38 wherein

the contrast improvement step comprises: a signal conversion step of converting a value of pixel in the input image to a plurality of signals that include the signal that is an object of contrast improvement; a step of finding a contrast improvement amount of the object pixel for an object signal obtained from the signal conversion step; a step of extracting an effective range from distribution of the contrast improvement amount for the object signal; an object signal conversion step of converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image; and a step of finding a value of pixel in the enhanced image based on the object signal of the enhanced image and signals other than the object signal obtained by the signal conversion step.

Claim 45 (Original) The image processing method of claim 38 wherein

the contrast improvement step comprises: a signal conversion step of converting a value of pixel in the input image to a signal that is an object of contrast improvement; a step of finding a contrast improvement amount by comparing the object signal of the object pixel with the object signals of pixels that belong to each of surrounding areas with different sizes; a step of extracting an effective range from distribution of the contrast improvement amount for the object signal; an

object signal conversion step of converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the extracted range; and a step of finding a value of pixel in the enhanced image based on the object signal of the enhanced image and signals other than the object signal obtained by the signal conversion step.

Claim 46 (Currently Amended) The image processing step of claim 44 or ~~claim 45~~ wherein
the object signal conversion step comprises: a step of calculating an average value of the object signal in the input image; a step of selecting a conversion method for converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image based on the average value; and step of converting the contrast improvement amount for the object signal to a value of the object signal in the enhanced image according to the selected conversion method.

Claim 47 (Currently Amended) The image processing method of claim 44 or ~~45~~ wherein
the object signal conversion step comprises: a step of calculating a standard intensity value that indicates contrast intensity of the input image for the object signal obtained by the signal conversion step; an object signal conversion curve estimation step of estimating a conversion curve for converting the contrast improvement amount for the object signal to a value in the enhanced image; and a step of using the estimated conversion curve to convert the contrast improvement amount for the object signal to a value in the enhanced image.

Claim 48 (Original) The image processing method of claim 47 wherein
the object signal conversion curve estimation step comprises: a step of setting an initial population of search vectors that indicate conversion curves; a step of finding conversion value for the object signal in a candidate for an enhanced image from the contrast improvement amount for the object signal using a conversion curve candidate corresponding to each search vector; a step of using the standard intensity value and the conversion value to calculate an evaluation value for evaluating the candidates of each conversion curve; a step of calculating fitness of the

candidates of each conversion curve based on the evaluation value; a step of performing recombination operation on a search vector selected based on the fitness of the candidates of each conversion curve and generating a next generation population; and a step of determining whether or not estimation of the conversion curve ends at current generation.

Claim 49 (Original) The image processing method of claim 38 wherein

the image combination step comprises: a selection standard judgment step of determining whether the input image or enhanced image has priority; a combination coefficient calculation step of setting combination coefficients for the input image and enhanced image based on the judgment of the selection standard judgment step; and a step of using the combination coefficients set for each image to generate a weighted average image of the input image and enhanced image.

Claim 50 (Original) An image processing method comprising:

a contrast improvement step of performing a contrast improvement process on an input image by comparing an object pixel of the input image with pixels that belong to surrounding areas of the object pixel;

an edge data detection step of detecting edge data of the input image;

an image combination step of combining an enhanced image obtained by the contrast improvement step with the input image based on the edge data obtained by the edge data detection step; and

a step of outputting an image after combination.

Claim 51 (Original) The image processing method of claim 50 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount for a pixel in the input image; a step of extracting an effective range from distribution of the contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 52 (Original) The image processing method of claim 50 wherein

the contrast improvement step comprises: a step of finding the contrast improvement amount by comparing the object pixel with a pixel that belong to each of surrounding areas of different sizes; a step of extracting an effective range from distribution of the contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

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Claim 53 (Original) The image processing method of claim 50 wherein

the image combination step comprises: a step of calculating combination coefficients for the input image and enhanced image based on the edge data obtained from the input image; and a step of generating a weighted average image for the input image and enhanced image based on the combination coefficients calculated for each image.

Claim 54 (Original) An image processing method comprising:

a contrast improvement step of performing a contrast improvement process on an input image by comparing an object pixel in the input image with pixels that belong to surrounding areas of the object pixel;

a density correction step of correcting density distribution of an enhanced image obtained by the contrast improvement step according to density distribution of the input image;

a step of combining a corrected image obtained by the density correction step and the input image; and

a step of outputting an image after combination.

Claim 55 (Original) The image process method of claim 54 wherein

the image combination step comprises: a weighted average combination step of generating a weighted average image for the input image and corrected image; and a step of setting a value of pixel in an output image based on the image obtained by the weighted average combination step and the input image.

Claim 56 (Original) An image processing method comprising:

an edge data detection step of detecting edge data of an input image;
a contrast improvement step of performing a contrast improvement process on the input image by determining an area where an object pixel belongs based on the edge data of the object pixel obtained by the edge data detection step and brightness of the object pixel, and by comparing the object pixel with pixels that belong to surrounding areas of the object pixel;
an image combination step of combining an enhanced image obtained by the contrast improvement step and the input image; and
a step of outputting an image after combination.

Claim 57 (Original) The image processing method of claim 56 wherein

the image combination step comprises: a weighted average combination step of generating a weighted average image for the input image and enhanced image; and a step of setting a value of pixel in the output image based on the image obtained by the weighted average combination step and the input image.

Claim 58 (Original) The image processing method of claim 56 wherein

the contrast improvement step comprises: an area judgment step of determining an area where the object pixel belongs based on edge data; a comparison range setting step of selecting a pixel comparison range based on the area obtained by the area judgment step; a step of finding a contrast improvement amount for the object pixel based on the pixel comparison range selected by the comparison range setting step; an adjustment coefficient calculation step of calculating an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment step; a step of correcting the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation step; a step of extracting an effective range from the corrected contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 59 (Original) The image processing method of claim 56 wherein
the contrast improvement step comprises: an area judgment step of determining an area where the object pixel belongs based on edge data; a step of finding a contrast improvement amount by comparing the object pixel with a pixel that belongs each of surrounding areas having different sizes; an adjustment coefficient calculation step of calculating an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment step; a step of correcting the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation step; a step of extracting an effective range from the corrected contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 60 (Original) An image processing method comprising:

a contrast improvement step of performing a contrast improvement process, in a state that density of a pixel in an area surrounding an object pixel in an input image is bound, on the input image by comparing the object pixel of the input image with a pixel of the surrounding area; and
a step of outputting an enhanced image obtained by the contrast improvement step.

Claim 61 (Original) An image processing method comprising:

a contrast improvement step of performing a contrast improvement process, in a state that density of a pixel in an area surrounding an object pixel in an input image is bound, on the input image by comparing the object pixel of the input image with a pixel of the surrounding area;
a step of combining an enhanced image obtained by the contrast improvement step and the input image; and
a step of outputting an image after combination.

Claim 62 (Currently Amended) The image processing method of claim 60 or claim 61
wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount of the object pixel; a step of extracting an effective range from distribution of contrast; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

Claim 63 (Currently Amended) The image processing method of claim 60 or claim 61 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; a step of extracting an effective range from distribution of the contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

Claim 64 (Original) An image processing method comprising:

- a pre-processing step of performing pre-processing on an input image;
- a contrast improvement step of performing a contrast improvement process on the pre-processed image by comparing an object pixel of the pre-processed image with pixels that belong to surrounding areas of the object pixel;
- a step of combining an enhanced image obtained by the contrast improvement step and the input image;
- a post-processing step of performing post-processing on an image after combination; and
- a step of outputting the post-processed image.

Claim 65 (Original) The image processing method of claim 64 wherein

the contrast improvement step comprises: a step of setting a comparison pixel from among pixels in the area surrounding the object pixel to be used in the comparison; a correction data calculation step of finding a contrast improvement amount of the object pixel; a step of finding a conversion standard value for converting the contrast improvement amount to a value of pixel in

the enhanced image; and a step of converting the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 66 (Original) The image processing method of claim 65 wherein

the correction data calculation step comprises: a surrounding average step of finding a weighted average for density of the comparison pixels; and a step of finding a contrast improvement amount from the average density obtained by the surrounding average step and density of the object pixel.

Claim 67 (Original) The image processing method of claim 65 wherein

the correction data calculation step comprises: a surrounding average step of finding a weighted average for the density of the comparison pixels; an edge data detection step of detecting edge data of the object pixel; a step of calculating a correction coefficient for the edge data based on the edge data obtained by the edge data detection step; a step of correcting the average density obtained by the surrounding average step using the correction coefficient; and a step of finding a contrast improvement amount from the corrected average density and the density of the object pixel.

Claim 68 (Original) The image processing method of claim 65 wherein

the correction data calculation step comprises: a surrounding average step of finding a weighted average for density of the comparison pixels; a step of finding a contrast improvement amount from the average density obtained by the surrounding average step and the density of the object pixel; a step of calculating an enhancement component from difference in the density of the comparison pixel and the object pixel; and a step of adding the enhancement component to the contrast improvement amount to correct the contrast improvement amount.

Claim 69 (Original) The image processing method of claim 64 wherein

the contrast improvement step comprises: a step of setting positions in a vertical direction of pixels to be used in the comparison from among pixels in the area surrounding the object pixel; a vertical direction addition step of adding weighting in the vertical direction to the density of the comparison pixels obtained by the setting; a step of calculating comparison density for the object pixel from a value at each horizontal pixel position in the surrounding area obtained by the vertical direction addition step; a step of finding a contrast improvement amount from the comparison density and density of the object pixel; a step of finding a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a step of converting the contrast improvement amount to a value of the pixel in the enhanced image based on the conversion standard value.

Claim 70 (Original) The image processing method of claim 64 wherein

the contrast improvement step comprises: a step of setting positions in a vertical direction and positions in a horizontal direction of pixels to be used in the comparison from among pixels in the area surrounding the object pixel; a removal vertical direction addition step of adding weighting to the vertical direction of the density of the comparison pixels obtained by the setting; a step of calculating comparison density for the object pixel based on an addition value obtained by the removal vertical direction addition step; a step of finding a contrast improvement amount from the comparison density and density of the object pixel; a step of finding a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a step of converting the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 71 (Original) The image processing method of claim 64 wherein

the pre-processing performs inverse conversion of gamma conversion on the input image in advance.

Claim 72 (Original) The image processing method of claim 64 wherein

the post-processing performs gamma conversion.

Claim 73 (Original) The image processing method of claim 64 wherein
the post-processing step comprises: an input brightness/color calculation step of calculating a brightness value and color difference components of the input image; a brightness adjustment step of comparing a brightness component of the input image obtained by the input brightness/color calculation step with the brightness component of a combined image and adjusting the brightness component of the combined image; a color component correction step of correcting the color difference components of the input image obtained by the input brightness/color calculation step based on the brightness component of the combined image obtained by the brightness adjustment step; an image regeneration step of regenerating the combined image using the brightness component of the combined image obtained by the brightness adjustment step and the corrected color difference components obtained by the color component correction step; and a step of performing gamma conversion on the combined image obtained by the image regeneration step.

Claim 74 (New) The image processing apparatus of claim 21 wherein
the contrast improvement unit comprises: an area judgment unit operable to determine an area where the object pixel belongs based on edge data; a comparison range setting unit operable to select a pixel comparison range based on the area obtained by the area judgment unit; a correction data calculation unit operable to find a contrast improvement amount for the object pixel based on the pixel comparison range selected by the comparison range setting unit; an adjustment coefficient calculation unit operable to calculate an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment unit; an adjustment unit operable to correct the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation unit; an extraction unit operable to extract an effective range from distribution of the corrected contrast improvement amount; and a pixel value conversion unit operable to convert the contrast improvement amount of the object

pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 75 (New) The image processing apparatus of claim 21 wherein

the contrast improvement unit comprises: an area judgment unit operable to determine an area where the object pixel belongs based on the edge data; a correction data calculation unit operable to find a contrast improvement amount by comparing the object pixel with a pixel that belongs to each of surrounding areas having different sizes; an adjustment coefficient calculation unit operable to calculate an adjustment coefficient for the contrast improvement amount based on the area obtained by the area judgment unit; an adjustment unit operable to correct the contrast improvement amount using the adjustment coefficient obtained by the adjustment coefficient calculation unit; an extraction unit operable to extract an effective range from distribution of the corrected contrast improvement amount; and a pixel value conversion unit operable to convert the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image according to the extracted range.

Claim 76 (New) The image processing apparatus of claim 25 wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount of the object pixel; an extraction unit operable to extract an effective range from distribution of contrast; and a pixel value conversion unit operable to convert the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

Claim 77 (New) The image processing apparatus of claim 25 wherein

the contrast improvement unit comprises: a correction data calculation unit operable to find a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; an extraction unit operable to extract an effective range from distribution of the contrast improvement amount; and a pixel value conversion unit operable

to convert the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

Claim 78 (New) The image processing apparatus of claim 17 wherein
the contrast improvement unit comprises: a comparison pixel setting unit operable to set comparison pixels from among pixels in the area surrounding the object pixel to be used in the comparison; a correction data calculation unit operable to find a contrast improvement amount of the object pixel; a conversion standard value calculation unit operable to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 79 (New) The image processing apparatus of claim 17 wherein
the contrast improvement unit comprises: a comparison pixel setting unit operable to set positions in a vertical direction of pixels to be used in the comparison from among pixels in the area surrounding the object pixel; a vertical direction addition unit operable to add weighting in the vertical direction to the density of the comparison pixels obtained by the comparison pixel setting unit; a simple surrounding average unit operable to calculate comparison density for the object pixel from a value at each horizontal pixel position in the surrounding area obtained by the vertical direction addition unit; an improvement amount calculation unit operable to find a contrast improvement amount from the comparison density and density of the object pixel; a conversion standard value calculation unit operable to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 80 (New) The image processing apparatus of claim 17 wherein

the contrast improvement unit comprises: a comparison pixel setting unit operable to set positions in a vertical direction and positions in a horizontal direction of pixels to be used in the comparison from among pixels in the area surrounding the object pixel ; a removal vertical direction addition unit operable to add weighting to the vertical direction of the density of the comparison pixels obtained by the comparison pixel setting unit; a simple surrounding average unit operable to calculate comparison density for the object pixel based on an addition value obtained by the removal vertical direction addition unit; an improvement amount calculation unit operable to find a contrast improvement amount from the comparison density and density of the object pixel; a conversion standard value calculation unit operable to find a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a pixel value conversion unit operable to convert the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 81 (New) The image processing apparatus of claim 17 wherein

the post-processing unit comprises: an input brightness/color calculation unit operable to calculate a brightness value and color difference components of the input image; a brightness adjustment unit operable to compare a brightness component of the input image obtained by the input brightness/color calculation unit with the brightness component of a combined image and adjust the brightness component of the combined image; a color component correction unit operable to correct the color difference components of the input image obtained by the input brightness/color calculation unit based on the brightness component of the combined image obtained by the brightness adjustment unit; an image regeneration unit operable to regenerate the combined image using the brightness component of the combined image obtained by the brightness adjustment unit and the corrected color difference components obtained by the color component correction unit; and a gamma conversion unit operable to perform gamma conversion on the combined image obtained by the image regeneration unit.

Claim 82 (New) The image processing method of claim 61 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount of the object pixel; a step of extracting an effective range from distribution of contrast; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

Claim 83 (New) The image processing method of claim 61 wherein

the contrast improvement step comprises: a step of finding a contrast improvement amount by comparing the object pixel with pixels that belong to each of surrounding areas with different sizes; a step of extracting an effective range from distribution of the contrast improvement amount; and a step of converting the contrast improvement amount of the object pixel to a value of corresponding pixel in the enhanced image.

Claim 84 (New) The image processing method of claim 38 wherein

the contrast improvement step comprises: a step of setting a comparison pixel from among pixels in the area surrounding the object pixel to be used in the comparison; a correction data calculation step of finding a contrast improvement amount of the object pixel; a step of finding a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a step of converting the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 85 (New) The image processing method of claim 38 wherein

the contrast improvement step comprises: a step of setting positions in a vertical direction of pixels to be used in the comparison from among pixels in the area surrounding the object pixel; a vertical direction addition step of adding weighting in the vertical direction to the density of the comparison pixels obtained by the setting; a step of calculating comparison density for the object pixel from a value at each horizontal pixel position in the surrounding area obtained by the vertical direction addition step; a step of finding a contrast improvement amount from the comparison density and density of the object pixel; a step of finding a conversion standard value for

converting the contrast improvement amount to a value of pixel in the enhanced image; and a step of converting the contrast improvement amount to a value of the pixel in the enhanced image based on the conversion standard value.

Claim 86 (New) The image processing method of claim 38 wherein

the contrast improvement step comprises: a step of setting positions in a vertical direction and positions in a horizontal direction of pixels to be used in the comparison from among pixels in the area surrounding the object pixel; a removal vertical direction addition step of adding weighting to the vertical direction of the density of the comparison pixels obtained by the setting; a step of calculating comparison density for the object pixel based on an addition value obtained by the removal vertical direction addition step; a step of finding a contrast improvement amount from the comparison density and density of the object pixel; a step of finding a conversion standard value for converting the contrast improvement amount to a value of pixel in the enhanced image; and a step of converting the contrast improvement amount to a value of pixel in the enhanced image based on the conversion standard value.

Claim 87 (New) The image processing method of claim 38 wherein

the post-processing step comprises: an input brightness/color calculation step of calculating a brightness value and color difference components of the input image; a brightness adjustment step of comparing a brightness component of the input image obtained by the input brightness/color calculation step with the brightness component of a combined image and adjusting the brightness component of the combined image; a color component correction step of correcting the color difference components of the input image obtained by the input brightness/color calculation step based on the brightness component of the combined image obtained by the brightness adjustment step; an image regeneration step of regenerating the combined image using the brightness component of the combined image obtained by the brightness adjustment step and the corrected color difference components obtained by the color

component correction step; and a step of performing gamma conversion on the combined image obtained by the image regeneration step.